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## A Comparison of the Prevalence and Risk Factors of High Blood Pressure among Japanese Living in Japan, Hawaii, and Los Angeles

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### SYNOPSIS

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THE AUTHORS STUDIED THE PREVALENCE AND RISK FACTORS of hypertension in samples of 2053 Japanese ages 40 to 70 in Hiroshima, Hawaii, and Los Angeles. The prevalence of hypertension (systolic blood pressure greater than or equal to 140 mmHg, diastolic blood pressure greater than or equal to 90 mmHg, or receiving antihypertensive drug treatment) was higher in Hawaii and Los Angeles for both sexes and almost all ages than in Hiroshima. The age- and sex-adjusted prevalence of hypertension in Hawaii, Los Angeles, and Hiroshima was 42.6%, 37.2%, and 29.7%.

Hypertension was associated with a significant elevation in serum glucose, insulin, triglyceride, and total cholesterol levels in the combined participant population of Hawaii, Los Angeles, and Hiroshima. Age- and sex-adjusted mean values of serum total cholesterol, triglyceride, and insulin were highest in Hawaii and lowest in Hiroshima. The mean body mass index and 2-hour serum glucose levels were greatest in Hawaii and equal in the two other cohorts. These results suggest that hyperinsulinemia and hyperlipidemia may explain the prevalence of hypertension in the research participants.

Since 1970, the Second Department of Internal Medicine, School of Medicine, Hiroshima University, has been engaged in an ongoing study of Japanese Americans in Hawaii and Los Angeles who were born in Hiroshima. Kawate and others (1) reported that Japanese Americans in Hawaii had a higher prevalence of hyperinsulinemia and dyslipidemia than Japanese living in Hiroshima.

In 1969, Welborn and others (2) demonstrated that a proportion of patients with high blood pressure had higher than normal plasma insulin concentrations, and recent reports (3-9) have confirmed that people with high blood pressure are more often hyperinsulinemic than people with normal blood pressure. Most investigators have suggested that insulin resistance and resultant hyperinsulinemia are the key metabolic abnormalities that link hypertension, obesity, diabetes, and dyslipidemia. This study was conducted to compare the relationship between hyperinsulinemia and hypertension in Japanese living in Hawaii, Los Angeles, and Hiroshima.

**Table 1. Age- and sex-specified prevalence of hypertension**

	Age	Hawaii			Los Angeles			Hiroshima			
		n	Hypertension		n	Hypertension		n	Hypertension		
			n	%		n	%		n	%	
Male	40-49	11	4	36.4	38	7	18.4	32	9	28.1	
	50-59	26	11	42.3	60	32	53.3	43	9	20.9	
	60-69	75	42	56.0	116	54	46.6	98	44	44.9	
	70-79	69	41	59.4	89	52	58.4	35	21	60.0	
Female	40-49	13	4	30.8	70	11	15.7	150	25	16.7	
	50-59	44	12	27.3	107	39	36.4	272	71	26.1	
	60-69	125	71	56.8	169	82	48.5	222	82	36.9	
	70-79	73	49	67.1	84	49	58.3	32	12	37.5	
Age- and Sex-Adjusted				42.6					37.2	29.7	

**Table 2. Physiologic and metabolic parameters of normotensive and hypertensive subjects**

	Normotensive Subjects		Hypertensive Subjects		P value
	Mean	s	Mean	s	
Age (yrs)	58.4	9.6	63.7	8.7	0.0001
Body Mass Index (kg/m <sup>2</sup> )	22.7	3.0	24.0	3.3	0.0001
Fasting Serum Glucose (mg/dl)	93.7	22.4	100.8	26.5	0.0001
2-hr Serum Glucose (mg/d)	122.2	55.5	148.1	74.7	0.0001
Fasting Serum Insulin (mU/l)	13.1	8.1	15.5	8.7	0.0001
2-hr Serum Insulin (mU/l)	61.3	41.5	78.8	49.4	0.0001
Serum Triglyceride (mg/dl)	113.8	82.5	161.8	156.9	0.0001
Serum Total Cholesterol (mg/dl)	221.5	38.7	222.9	41.5	0.0001
Serum HDL Cholesterol (mg/dl)	54.3	38.7	51.0	14.2	0.0001
Serum Uric Acid (mg/dl)	4.8	1.3	5.6	1.6	0.0001

**Methods**

Participants were native Japanese ages 40 to 79 living in Hawaii (n=436), Los Angeles (n=733), and Hiroshima (n=884), who underwent medical examination in our survey in 1986 and 1988. All participants had a physical examination after an overnight fast. We recorded weight and height and measured blood pressure with a mercury sphygmomanometer with people supine after a 15-minute rest. Systolic and diastolic blood pressure were determined by the first and fifth Korotkoff sounds. When initial blood pressure levels were high (diastolic pressure ≥90 mmHg; systolic pressure ≥140 mmHg), we remeasured and reported the second levels.

We drew fasting blood samples for serum glucose, insulin, lipids, and uric acid, as well as serum glucose and insulin determination at 1 and 2 hours of a 75-gram oral glucose tolerance test.

We defined hypertension as blood pressure higher than 140 mmHg systolic or 90 mmHg diastolic, or taking antihypertensive medication. Body mass index (BMI), calculated as weight in kilograms divided by the square of height in meters, was used as a measure of obesity. Glucose was determined by Hoffman's method using an auto-analyzer, insulin by the double antibody method. Serum cholesterol and serum triglyceride were analyzed using

enzymatic methods. We performed other analyses with methods used routinely at the Department of Clinical Chemistry, Hiroshima General Hospital.

Values were presented as means ±s. We used two-tailed student's unpaired t tests to compare group differences, and performed chi-square analysis for discrete variables. We analyzed correlations by simple linear regression, and performed multivariate analysis with the logistic regression model. Physiologic and metabolic parameters and hypertension prevalence rates were age- and sex-adjusted by the direct method with the 1988 Japan census of the Japanese population as the standard.

**Results**

Table 1 shows the age- and sex-specific prevalence rates of hypertension in Japanese living in Hawaii, Los Angeles, and Hiroshima. The prevalence of hypertension was higher in Hawaii and Los Angeles than in Hiroshima for both sexes and almost all ages. The age- and sex-adjusted prevalence of hypertension in Hawaii, Los Angeles, and Hiroshima was 42.6%, 37.2%, and 29.7%.

Hypertension was positively related to age, BMI, serum glucose, insulin, triglyceride, total cholesterol, and uric acid levels, and inversely to serum HDL cholesterol levels, using the combined populations of the Hawaii, Los Angeles, and Hiroshima samples (Table 2). Among those not taking antihypertensive drugs, the above parameters were also significantly related to hypertension.

Adjusted for age, sex, BMI, serum total cholesterol, triglyceride, and fasting glucose levels, 2-hour serum insulin concentration was significantly related to hypertension. In simple regression analysis, systolic blood pressure was positively related to serum insulin, glucose, total cholesterol, triglyceride, and uric acid levels among those not receiving antihypertensive or hypoglycemic drugs. Age- and sex-adjusted mean values of systolic blood pressure, serum total cholesterol, triglyceride, and insulin were highest in Hawaii and lowest in Hiroshima. The mean body mass index and 2-hour serum glucose levels were greatest in Hawaii and were equal in Los Angeles and Hiroshima.

## Discussion

We found a significant difference in the prevalence of hypertension between Japanese Americans in Hawaii and Los Angeles and Japanese in Hiroshima. The prevalence of glucose intolerance, hyperinsulinemia, and dyslipidemia was higher in Hawaii and Los Angeles than in Hiroshima. The association among hypertension, glucose intolerance, and hyperinsulinemia suggested a common pathogenic mechanism.

This finding suggests that hyperinsulinemia and dyslipidemia may explain the observed gradient in the prevalence of hypertension in the three cohorts. Because the research participants were native Japanese, almost all born in Hiroshima, the difference in the prevalence of hypertension, glucose intolerance, hyperinsulinemia, and dyslipidemia may be attributable to differences in environmental rather than genetic factors. We have previously suggested that nutrient intake, especially high animal fat, high simple carbohydrates, and low complex carbohydrates, and low physical activity cause dyslipidemia and hyperinsulinemia in the three cohorts (10,11).

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